Information superhighway

Background Paper

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INFORMATION SUPERHIGHWAY

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INFORMATION SUPERHIGHWAY

BACKGROUND

Over the past 10 years, Canadians have become increasingly aware that in the society of the future knowledge will be more important than natural resources to the global economy and products and services will be deliverable anywhere on the planet. This society is taking shape before our eyes; many of the basic enabling technologies are already in place.

The important components of a knowledge-based society are data collection, dissemination and processing. The amount of information in all forms has been increasing more rapidly than the ability of the infrastructure to distribute it. Development of a modern information highway that would allow full exploitation of the available information is paramount if the potential of the new society is to be realized. Much of the primary transmission capability is already available; still lacking are the necessary high-speed "on and off ramps" allowing universal access.

This paper reviews the major technological components of the highway, the current situation in Canada and the U.S., and some of the future options. Also covered will be some actions that can be taken to expedite the availability and use of an effective Canadian information superhighway.

CONCEPT AND BENEFITS

The term "information superhighway" has many different meanings, depending on the context. The superhighway consists of three key elements in addition to the

communications infrastructure (the telephone and cable systems) that permit two-way communication. These elements are:

- the software that permits the easy use of the services and information available on the highway;
- information appliances, such as TVs, telephones and computers, and new products combining all three; and
- information providers - local broadcasters, digital libraries, information services (where most of the new jobs are anticipated), and millions of individuals.

The development and integration of all the components will produce the total system. The very wide range of applications envisaged for such a system will affect:

Public Institutions: The superhighway is seen as a means of improving the delivery of public services and permitting citizens to have easy access to government information. In the health field, specialist physicians would be able to consult with patients in outlying areas while having direct access to the results of X-rays, ultrasound, CAT scans, etc. located with the patient. Similarly, in the field of education, students could have access to specialized support personnel and to much more extensive information than is now possible.

Private Sector: The information superhighway could more readily enable the formation of more effective teams with members located at various centres; thus, information-related businesses could be located virtually anywhere. The superhighway would also provide an opportunity to establish numerous value-added information-related services.

Private Citizen: In addition to the services mentioned above, this highway would give private citizens access to at-home shopping, video on demand, and up-to-date information through news, electronic books, on-line databases, etc.

TECHNOLOGIES FOR DELIVERING INFORMATION

Over the last two decades, and particularly in the 1980s, communications and information technology have undergone a profound revolution. The computer has evolved from

an esoteric big business and scientific tool to a consumer good found in an ever-growing percentage of homes. Similarly, communications technology has evolved from the basic voice telephone into a complicated system - one that includes cellular phones, faxes and video conferencing - on which we will depend for the delivery of information in the future.

The three major types of technological innovation that have driven fundamental changes in the communications sector are: digital communication (particularly digital switching), wireless communication, and fibre-optic transmission. Below is a summary of each of these, followed by an overview of possible methods of delivering high volumes of information to the homes of consumers.

A. Digital Communication

The first digital switching equipment was introduced in the late 1970s. It consists of digital switches, essentially specialized computers that allow networks to be customized and reconfigured through relatively simple software changes. This digital technology makes possible such services as caller identification. Developed countries like Canada have been moving rapidly to adopt digital technology in their telephone networks. By 1992, it was being used in 85% of Bell Canada's trunk lines and 35% of its local lines and it is anticipated that by 1995 virtually the entire Bell Canada network will be digital.(1)

B. Wireless Communication

In parallel with the swift growth of hard-wired delivery technology, innovations in wireless communication, particularly cellular telephones; have also progressed very quickly. The cellular network began its first full year of operation in Canada in 1986. Both Canada and the United States have experienced very high growth rates in this field and the number of users is expected to increase rapidly as quality improves and costs decrease still further. These changes will be brought about in part by the switch from conventional analog to digital radio transmissions which began in 1994. Most carriers are not expected to go digital until 1995 or

(1) Science Council of Canada, *The Canadian Telecommunications Sector, Sectoral Technology Strategy Series No. 1*, Minister of Supply and Services, Ottawa, 1992, p. 3.

later.[(2)] In developing countries, it is quite possible that cellular networks will supersede conventional land-based networks by the late 1990s.

C. Fibre-Optic Transmission

The major virtue of optical fibre is its huge capacity to carry information. This can be illustrated by a comparison of the relative amount of information each type of line can carry:[(3)]

Telephone wire	1 to 24,
Coaxial cable	1,000,
Fibre-optic cable	10,000.

Fibre-optic transmission also offers several other advantages:[(4)]

- Signals are of very high quality and noise-free. This corresponds to very low error rates for data communications.

- The signals are free from the disruptive environmental interferences that often degrade copper or wireless communications. Fibre-optic cables can operate reliably in electrically noisy environments without requiring shielding.

- Fibre-optic cables do not emit radiation and thus do not cause external interference. Moreover, they are relatively secure as the fibres are very difficult to tap without being detected.

- At a few cents per metre, the cables are less expensive, lighter and smaller than copper cable; they are thus cheaper and easier to install.

D. High-Capacity Delivery to Consumers

The current trend is for digital communications and fibre-optic networks to come closer to the end user; however, covering the last portion of a high-capacity delivery system

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(2) "When Cells Divide," *Scientific American*, December 1993, p. 44.

(3) Communications Canada, *Communications for the Twenty-First Century*, Minister of Supply and Services, Ottawa, 1987, p. 50.

(4) Department of Communications, *Fibre-Optics in Canada*, Information Services, Ottawa, 1986, p. 1.

remains the critical problem. Numerous options exist and their cost and current technical feasibility vary.

Connection via fibre-optics is still prohibitively expensive for individual households. According to Bell Canada, the cost of bringing optical fibre into the home is $2,000 to $3,000 per subscriber.

Cable TV companies are also expanding the use of fibre-optics in their networks. Both Toronto and Ottawa either have, or are in the process of being upgraded with, a fibre-optic main circuit. Fibre-optic cable has two principal advantages over coaxial cable: a much greater capacity to transmit information and a much lower rate of attenuation of signal strength. Coaxial cable signals must be boosted by a broad-band amplifier every few hundred metres or so, which inhibits two-way communication. To minimize the costs, the cable system can be upgraded to fibre optics to within 1.5 km of the user for a cost of $200 to $300 (U.S.) per customer, excluding the essential upgrading costs to the switching system used by the cable companies.(5)

Another option is to use fibre-optics for the most part, but to employ either wireless communication methods or coaxial cable for the last segment. Fibre-optics could be extended to within 100 metres of the end user, after which an alternative medium would complete the delivery, possibly employing encryption to enhance the privacy aspects and digital data compression to increase capacity.(6) Although feasible now, the implementation of a plan using wireless communication would require improvements in both cost effectiveness and higher transmission throughputs.

The use of fibre-optic cable or a wireless-based system to replace copper wire and coaxial cable would vastly expand the range and type of services available to the consumer. Services such as dial-up high definition TV movies, video tele-conferencing, interactive television, and electronic catalogue shopping would become feasible. The massive investment required to provide individual households with fibre-optic lines will, however, likely prevent the telephone and cable industries from installing separate complete networks.

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(5) Gary Stix, "Domesticating Cyberspace," *Scientific American*, August 1993, p. 103.

(6) *Ibid.*, p. 103-104.

DEVELOPMENTS IN CANADA

Government and industry are the major players in the development of an information superhighway and, while each views the highway with its own interests and expectations, both consider it to be a key element in their future plans.

A. Government

The federal government is responsible for the regulation of telecommunications and is also a major provider of information. The other levels of government are involved because of the close link between the information highway and education/training, a provincial responsibility.

1. General Developments

In its study of the information highway over many years, the Government of Canada has set up numerous committees. It also commissioned a study on how best to accelerate the development of the highway which culminated in a report, "The Electronic Connection: An Essential Key to Canadians' Survival," written by Bernard Ostry and published in 1993. This made a large number of recommendations on how Canada's electronic highway could be in place within five years.

Subsequently, on 2 February 1994, the Secretary of State for Science, Jon Gerrard, announced that the federal government envisions the information highway as a "national network of networks" incorporating both telephone and cable television traffic. As the various technologies merge, the government will apply policies favouring a competitive environment.(7) The government is ready to allow cable and telephone companies to operate in each other's area, but does not foresee an immediate convergence of broadcasting and telecommunication laws.

The government's objectives for the information highway continue to be: creating jobs, reinforcing Canadian sovereignty and cultural identity, and ensuring universal access at reasonable cost. The government is establishing an advisory council on information and

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(7) Jonathan Chevreau, "Ottawa To Push 'Open' Highway," *Financial Post*, 3 February 1994.

communications to be chaired by David Johnson of McGill University; an interim report is expected by September 1994.

2. CANARIE

The Canadian Network for the Advancement of Research, Industry and Education (CANARIE) project is a seven-year, $1.2-billion project that will eventually link industry, universities, and government through a fibre-optic and satellite data expressway. The project is expected to have important applications in areas as diverse as health care, pharmaceuticals, aerospace, the resource industries, finance and banking industries, education and training, media communications, and urban planning. A national, high-speed telecommunications backbone is seen as essential to making Canada more competitive internationally. The project addresses a serious weakness in a country that prides itself on its strength in the telecommunications sector: Canada is seen as lagging "far behind what the technology would allow and what most other developed countries already have in place."(8)

The CANARIE project states as its mission:(9)

> To support the development of the communications infrastructure for a knowledge-based Canada, and thereby contribute to Canadian competitiveness in all sectors of the economy, to prosperity, job creation, and to our quality of life.

The three main elements of the CANARIE project are to:

- upgrade the operational network from 56 kilobits per second to 1.544 megabits per second (T1), an increase of over 27 times the data transfer rate, with the objective of attaining a multi-gigabit per second rate, an increase of 1,000 times, over a seven-year period;
- establish a gigabit test facility to support the development of the next generation network technology; and
- put in place a Technology Development and Technology Diffusion Program.(10)

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(8) Doug Powell, "Supernetworks in Canada Play Catch-up," *Computing Canada*, 3 February 1992, p. 1, 6.

(9) Background material on CANARIE, CANARIE Inc., 2 September 1993.

(10) *Sommaire, plan d'entreprise CANARIE*, December 1992, p. 3.

The project will be implemented in three phases. In Phase 1, which will run from April 1993 to March 1995, the national R&D and research network CAnet, launched in October 1990, will be upgraded and a high-speed experimental test network will be established. Phase 1 will also see the initiation of product and service development for CANARIE. Total direct and indirect investment in Phase 1 will be $115 million, of which $26 million will be contributed by the federal government.

Phase 2 will last from April 1995 until March 1998. In Phase 2, the high-speed experimental network will be tested; the development of networking technologies, products, applications, and software will be continued; and CAnet will be further upgraded. Phase 2 is expected to cost $450 million.

During Phase 3, which will last from April 1998 to March 2000, applications and technologies will be shifted to operational networks and the completed network will be launched. The cost is expected to be $600 million.

Some observers have been critical of a number of aspects of CANARIE. A major concern is that the government, although it will pay up to a third of the cost and generate much of the traffic on the highway, has no seat on the board and will have little direct say in the development of the system. The government has effectively turned over the project to the private sector in order to save costs and speed up the project. This is in contrast to the situation in other countries, where the government is a major stakeholder in information highways. Building infrastructure is regarded by some as one of government's main responsibilities in economic development. This issue raises other concerns, such as who will eventually have access to the system.(11)

It is also claimed that CANARIE will not be able to keep pace with the rapidly developing telecommunications technologies, will be susceptible to conflicts of interest among its commercial sponsors, and may ultimately not be particularly useful to Canadian business.(12)

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(11) Alana Kainz, "Critics Wish Government Had Caged CANARIE Information Highway," *Ottawa Citizen*, 29 August 1993, p. A1.

(12) James Bagnall, "Why this CANARIE Isn't Going To Sing," *Financial Times of Canada*, 19 December 1992, p. 4.

B. Industry

1. General Developments

The major commercial players are the telephone companies, the cable companies (such as Vidéotron and Rogers Communications Inc.), the computer industry, the information delivery system, and the entertainment industry. Each sees the information highway as its future.

The delivery of information has changed and information is becoming increasingly digital. Digital information, whether the source is video, data, sound, or textual, is an organized stream of 0s and 1s (binary representation that can be coded as electrical pulses for data transmission) which can be delivered by many different means. Further, digital data permit many forms of digital processing; digital compression techniques that greatly expand the effective transmission rate of any medium are particularly important.

Until recently, the telephone and cable industries, encouraged by regulation, had developed quite separately, providing distinctly different services which used different technology and had differently configured networks. Fibre-optic technology is, in effect, driving a convergence between the telephone and cable industries companies that will enable both industries to provide a much wider range of services.

Both the telephone lines and coaxial cables to households could be replaced by a single fibre-optic line or a wireless system; however, the revenue from advanced services would be required to pay for the investment. Both industries would like to be able to install fibre-optics cable from the main networks into the home and have the rights to deliver more sophisticated interactive services.

There is now debate over how this issue can be best resolved. A recent report of the Co-chairs of the Local Networks Convergence Committee(13) found that preserving the "dual wire" infrastructure would make the telephone and cable industries more efficient than a single integrated network. It favoured, however, a flexible regulatory environment that would

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(13) Co-chairs of the Local Networks Convergence Committee, *Convergence: Competition and Cooperation*, Ministry of Supply and Services Canada, Ottawa, 1992, p. v.

support increased competition and at the same time facilitate co-operative ventures by telephone and cable companies.

In addition, many of the players are grouping themselves together for mutual support. Of the many competing systems, some will be winners and some losers. What people will want or be willing to pay for, however, remains uncertain.

2. Recent Initiatives

Major industrial stakeholders have recently taken some initiatives. The telephone companies continue to introduce digital communications and to extend the use of fibre-optics. The cable companies have already received approval from the CRTC for an increase in fees that would allow them to upgrade their systems. Maclean Hunter Ltd., a major cable and publishing company, has accepted an offer of purchase from Rogers Communications; this transaction would effectively create a super Canadian cable company, but remains to be ruled on by the CRTC.

Groupe Vidéotron Ltée, a major Quebec cable company, is leading a project to launch shop-at-home service in the province's homes. At a cost of $750 million over eight years, it will offer consumers numerous two-way electronic services, including browsing, shopping, banking, voting and adjusting energy consumption. The target is to bring the service to 34,000 homes in the Saguenay region by June 1995 and to 80% of Quebec homes by 2002.

Vidéotron has promised 80% penetration to its partners in this venture. Members of the consortium will pay for consumers to be issued with a personalized electronic "smart card" and reader, a special converter wand and a small transaction printer. International Business Machines Corp (IBM) has joined with Vidéotron to develop the electronic boxes used by the system and IBM will integrate the hardware, software and cabling needed for providing two-way electronic services.[14] The company hopes to launch a national platform by promising involvement with other cable companies in launching this service.[15]

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(14) Kevin Dougherty, "Vidéotron Links Up with IBM," *Financial Post*, 12 March 1994.

(15) Kevin Dougherty, "Vidéotron Maps Out Its Electronic Highway," *Financial Post*, 29 January 1994.

Stentor, a consortium of Canadian telephone companies, has launched several multi-media trials. In one trial, 400 students at Carleton University are using personal computers and standard telephone lines to test video on demand. The trial is based on a new technology developed by Northern Research that allows digitized video signals to be sent over standard phone lines and uses the new international video compression standard Motion Picture Experts Group 1. Other trials are underway to test the delivery of multi-media information through conventional phone lines.[16]

DEVELOPMENTS IN THE U.S.

Many important events are taking place in the U.S. both at the government level and in industry.

A. Government

Vice-President Al Gore has been a long-standing proponent of information superhighways, having proposed such a scheme as early as 1979. The current *High-Performance Computing Act* is a five-year, $3-billion initiative intended to facilitate research and development in high-performance computing. It commits $400 million (U.S.) to the construction of the National Research and Education Network (NREN), which will begin by making use of the current U.S. Internet. Initially, the NREN will connect more than a dozen leading research centres in the U.S. through a 1-3 gigabit-per-second[17] fibre-optic-based network using primarily fibre-optic cables already laid by the centres, the telephone companies, and the government.

Eventually, NREN is expected to displace the current computer network, Internet, which, although it is well suited to transmitting limited textual information, is prohibitively slow for transmitting large texts such as complete books, data bases, high resolution graphics, or full-motion video.

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(16) "Phone Companies Out Front," *Globe and Mail* (Toronto), 8 March 1994.

(17) Doug Powell, "Supernetworks in Canada Play Catch-Up," *Computing Canada*, 3 February 1992, p. 6.

The new system, a first step in the creation of an infrastructure for an information economy, is viewed as essential if the U.S. is to remain competitive. Japan, like some of the U.S.'s other main competitors, is already investing heavily in the fibre-optic cables and digital switches needed to create an information highway and plans to deliver fibre-optic cable to every household and school by the year 2015.

The U.S. program has raised doubts about whether the Canadian government is playing a large enough role in creating a globally competitive telecommunications infrastructure.(18) The U.S. federal funding is intended to catalyze investment by a wide variety of private companies, which (as in the case of CANARIE in Canada) are expected to supply most of the funding. In fact, the level of U.S. government investment does seem remarkably low when compared to the $75 billion spent in 1988 alone to build and maintain highways.(19) By comparison, the cost of installing fibre-optic lines to all U.S. homes has been estimated at less than $200 billion.

The creation of NREN has also raised the issue of access. It has been suggested that NREN should be more than a tool for scientists; it should be aimed at schools, hospitals and business from the start; otherwise it could widen the gap between rich and poor.

In December 1993, Vice-President Gore stated that the new information marketplace based on information highways would have involvement from four major groups:

- owners of the highways - built and paid for by the private sector;
- makers of the information appliances, such as TVs, telephones and computers and new products combining all three;
- information providers - local broadcasters, digital libraries, information service providers and millions of individuals; and
- information customers, demanding privacy, affordability and choice.

The Clinton Administration wants to create an environment that stimulates private systems of free-flowing information. It will support the removal, over time, in appropriate

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(18) *Ibid.*

(19) David Morris, "Information Highways," *Utne Reader*, September-October 1991, p. 117.

conditions, of judicial and legislative restrictions on all types of telecommunications companies: cable, telephone, utilities, television and satellites. These changes will be carried out in consultation with all the stakeholders (state, consumers, industry, etc.).

The principles to be followed by each of the components of the information superhighway are:

- encouragement of private investment (avoidance of over-regulation and monopolies);
- promoting and encouraging competition (prevention of unfair cross-subsidies);
- provision of open access to networks (to ensure that the companies that own the network cannot use their control to limit what is available);
- avoiding creation of a society of information "haves" and "have nots" (particularly important with respect to low-cost, universal access and the education of children); and
- encouragement of flexibility (technology is advancing so quickly that all policies must be broad enough to accommodate change).

On 11 January 1994, Vice-President Gore proposed that the U.S. government would greatly reduce regulation in many areas of telecommunications. Specifically, this proposal would allow telephone companies to enter the cable business and cable companies to enter the telephone business. With the current trade laws having virtually eliminated boundaries, will Canada have any choice but to follow the U.S. example in this area?

The American White House representative, Michael Nelson, made an enlightening comment at a conference on information superhighways in early February 1994; he said that access to Canada was a planned extension of the U.S. information superhighway.[20]

B. Industry

Several major mergers between American cable, computer, entertainment and telecommunications companies have been reported in recent months. Some of these have failed, while others are proceeding at a slow pace.

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(20) Alana Kainz, "Information Super-Overload at Superhighway Conference," *Ottawa Citizen*, 3 February 1994.

In 1993, Microsoft, a major software company, failed in an attempt to establish a system for interactive TV in a major venture with Time Warner Inc., an entertainment company, and Tele-Communication Inc. (TCI), the largest cable company in the U.S. This year, Microsoft and TCI agreed to a more limited joint venture with a similar aim.(21)

In February 1994, the attempt to acquire TCI by Bell Atlantic Corp., a major telephone company providing services to six mid-Atlantic states and Washington, failed. In early March 1994, Bell Atlantic issued a worldwide call to software developers to prepare software for its interactive network. By the end of 1995, the company plans to wire 1.2 million homes in its region for interactive services.(22)

The Continental Cablevision Inc. and Performance Systems International Inc. are offering the first cable service linking home computers to Internet. Starting in a Boston suburb, the service will eventually be expanded to the 2.9 million cable homes in New England, the Midwest, California, and Florida. This system will allow high speed communications between home users and Internet, data transmission rates up to 200 times faster than 2,400-bit-per-second transmissions currently available to home users. The cost of this service will be high: $125 per month for home users and $2,000 to $2,750 per month for businesses. Other cable companies are also exploring the possibility of offering this service.(23)

Many different mergers and strategic alliances and test services are being undertaken in the U.S. Is this trend an indication of what can be expected? Although many of these developments will fail, it is likely that others will succeed in finding cost-effective methods of providing services for which people are willing to pay.

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(21) G. Pascal Zachary and Mark Robichaux, "Microsoft and Tele-Communications To Launch TV Channel on Computers," *The Wall Street Journal*, 8 March 1994.

(22) "Bell Atlantic Is Issuing World-Wide Call for Software for Its Interactive Network," *The Wall Street Journal*, 8 March 1994.

(23) Jared Sandberg, "Cable That Ties PCs to Internet To Be Revealed," *The Wall Street Journal*, 8 March 1994.

ISSUES OF CONCERN

Some of the concerns related to the development and implementation of a Canadian information highway are:

- What form of access will it have? How can we ensure that the poor are not by-passed in this process?

- How do we get there? Will governments provide the regulatory environment and let businesses fight it out or will the government be more active in building the system?

- Who pays and for what? The proportions paid by the government and private business will directly affect how much the consumer pays and what, if any, free core services will be available. Should consumers pay to upgrade an infrastructure that possibly only a small proportion of individuals will use in the immediate future? Will the consumer go along with the new services and be willing to pay for them?

- What applications should be available on the system, both commercial and public? Will the only services be pay-as-you-use commercial services or will public service applications (e.g., access to libraries, education, government services) also be available?

- Will the basic use of the system be affordable? If not, will only businesses and government institutions (schools, hospitals, etc.) be able to use it?

- Will privacy be at risk? Information related to spending habits, etc. could be logged and sold for its commercial value, but would this infringe on individual privacy?

- Will a particular cultural or linguistic content be possible, particularly in Quebec? With the U.S. connected to the highway, vast quantities of U.S. material will be readily available. Will people simply bypass services regulated by the CRTC or another government agency

and get them directly from the U.S.? Censorship and content rules could be difficult if not impossible to enforce, since alternatives for rerouting information are built into the system.

- What will be the impact of the probable merger of telephone, cable, entertainment and information companies on the relatively small Canadian market? This merger is already happening in the U.S. How can the government provide some protection for consumers?

- What approach should be taken with respect to the possible displacement of workers as new services replace traditional means of shopping, banking, etc.?

- What impact, if any, would the highway have on the existing Internet system and current providers of commercial information, such as Compuserve, etc.? How can they be integrated into a future system?

WHAT CAN GOVERNMENT DO?

The government can take a wide range of initiatives to enhance the development of an information highway in Canada. The Ostry Report provides a comprehensive initial set of recommendations, one being that the Prime Minister should make a statement on the vision and purpose of the electronic highway system. This would encourage all the stakeholders to work on the issues.

The Ostry Report also proposed the establishment of eight operational, outcome-oriented task forces, which would report back to the Prime Minister within 18 months. The various task forces would deal with:

- architecture and technology requirements (led by industry - Stentor or Unitel);
- standards, protocols and regulations (led by the CRTC and consumer and industry lawyers);
- education and training needs (led by education stakeholders);
- design of new software for training and education (led by private sector specialists);

- delivery of the wide range of existing software;
- international concerns (working with CLIN, World ORT, Europe, etc.);
- concern about whether the system should be community-based though it serves individuals; and
- cost-effective use of the system.

The consensual report would then be reviewed by the appropriate Ministers and Deputy Ministers. This would leave three years, of the proposed five, for pilot projects, testing and implementation.

As suggested in a recent report, the government could make clear its support for preserving the "dual wire" infrastructure, cable and telephone, which would result in a more efficient system than a single integrated network. The government could continue to explain measures for making the regulatory environment more flexible so as to support increased competition and facilitate cooperative ventures by telephone and cable companies.

CONCLUSION

Canada needs an electronic highway that should:

- help us solve educational problems;
- improve our competitive position in international trade by ensuring a highly skilled workforce;
- promote self-reliance in people and Canada;
- provide business and universities with improved channels of communication;
- strengthen our national identity;
- integrate government services so that they are more efficient and effective; and
- help build "Team Canada."

Canada is technically well equipped to deliver an electronic highway. We have an excellent communication system and two extensive digital telecommunications organizations

(Unitel and Stentor). The two carriers form an infrastructure that is already 95% digitized, versus 60% in the U.S. In addition, most homes are served by cable companies. These companies and many of the provinces want the federal government to take the lead.

The electronic highway will allow greater possibilities for value-added or knowledge-based economies. As a nation, Canada can either proceed with the rapid development of an information highway or lose the critically important edge it needs.

The remaining question is: how quickly should we build this highway? If it is in place before effective services for which consumers are willing to pay, who will bear the cost?

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